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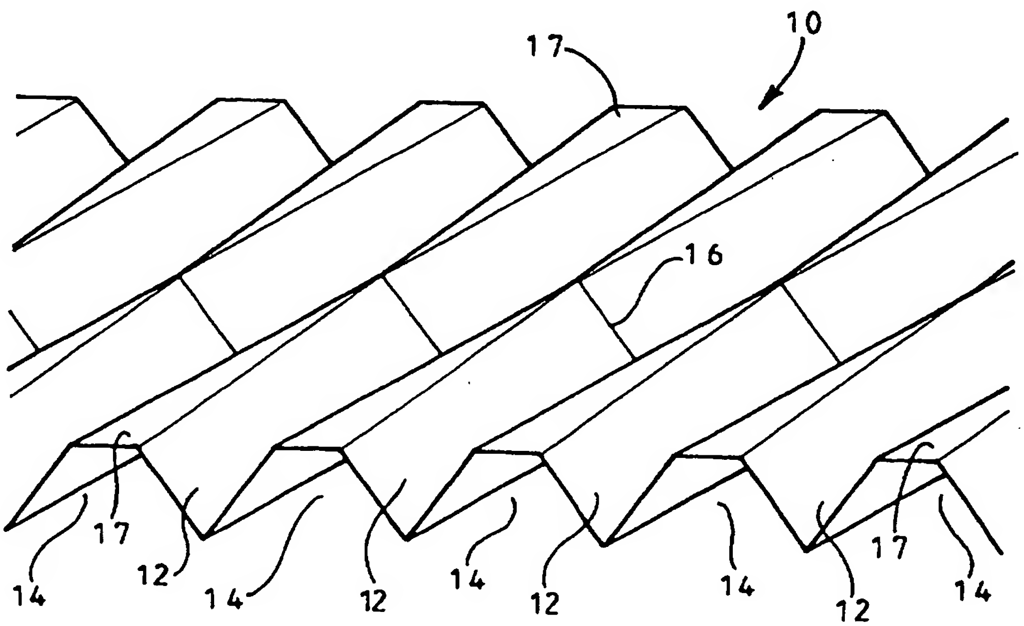

(57) Abstract

Structured packing sheet (10) is for promoting contact between two streams in a tower or column. The sheet (10) has corrugations therein defining a set of first channels (12) opening onto one surface of the sheet (10) alternating with a set of second channels opening onto the opposite surface of the sheet. The channels (12) and (14) extend between opposite side edges of the sheet (10). The cross-sectional area of each channel (12) or (14), as measured in a plane perpendicular to the medial line of the channel, charges longitudinally of the channel.

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STRUCTURED PACKINGS

This invention relates to structured packings. Structured packings are regularly used to bring a gas or vapour stream into close contact with a liquid stream in order to achieve high heat and/or mass transfer rates in, for example, cooling towers, absorbtion columns and distillation columns. Examples of such structured packings are disclosed in US Patents 4296050, 4455339 and 4497752 and in EP-A-0209898.

Such structured packings are produced by superimposing a plurality of corrugated packing sheets to form blocks wherein, in each block, the corrugations in each sheet extend at an opposite angle to those of an adjacent sheet in the block. A series of such blocks are then stacked one on top of the other in the tower or column so that each packing sheet is vertically disposed in the tower or column and has its corrugations lying at an angle to the direction of bulk flow through the tower or column. The blocks are arranged so that the corrugations in each sheet extend at an opposite angle to those in the corresponding sheet of the immediately adjacent block or blocks. These packings are designed to promote mixing and spreading in both the liquid and vapour phases.

It is an object of a first aspect of the present invention to provide a novel structured packing sheet construction which can enable the size and cost of a column or tower fitted with such packing sheets to be reduced by intensifying the mass and/or heat transfer process in the packing in use.

According to said first aspect of the present invention, there is provided a structured packing sheet for promoting contact between two streams (e.g a gas or vapour stream and a liquid stream) in a tower or column (e.g a

cooling tower, an absorbtion column or a distillation column), said structured packing sheet having corrugations therein defining a set of first channels opening onto one surface of the sheet alternating with a set of second channels opening onto the opposite surface of the sheet, the channels extending between opposite side edges of the sheet, wherein the cross-sectional area of each channel (as measured in a plane perpendicular to the medial line of the channel) changes longitudinally of the channel.

Most preferably, each channel has opposed longitudinal side edges which are mutually separated, in a direction parallel to the side edges of the sheet, by a distance which varies longitudinally of the direction of extent of the channel. This separation direction is perpendicular to the general direction of flow of fluid in use from one side edge of the sheet to the opposite side edge.

The channels are most preferably linear because for ease of manufacture. However, it is within the scope of the invention for the channels to be curved or otherwise non-linear in their directions of extent.

In one set of embodiments, the cross-sectional area of each channel changes longitudinally from relatively large to relatively small at least once over the length thereof. Conveniently, the cross-sectional area of each of the first channels changes longitudinally from a maximum at each end thereof to a minimum at a location intermediate said ends (preferably mid-way between the ends), whilst the cross-sectional area of each of the second channels changes from a minimum at each of its ends to a maximum at a corresponding location intermediate the ends. The

change in the cross-sectional area of each channel may be substantially progressive.

In another set of embodiments, at least one opening in each channel providing intercommunication between opposite sides of the sheet is defined by an abrupt change in the cross-sectional areas of the channel at least one intermediate location intermediate the ends of the channel. Preferably, the cross-sectional area of each of the first channels changes from a maximum at one of its ends to a minimum at said intermediate location, but changes from a minimum at the opposite end to a maximum at said intermediate location, the second channels being of complementary shape to the first channels so that said opening is defined in each channel.

With a structured packing sheet according to said first aspect of the present invention, turbulence is increased, particularly in the vapour or gas phase where a gas or vapour stream is being contacted with a liquid stream. This serves to improve mixing and turbulence in the vapour phase.

According to a second aspect of the present invention, there is provided a column or tower containing a plurality of packing sheets according to said first aspect of the present invention, wherein the packing sheets are disposed in the column or tower so that their planes extend in the direction of extent of said column or tower or are inclined relative thereto.

The packing sheets are preferably arranged in blocks which are stacked in the column or tower. All commercially available packings have

blocks which are between 180 and 350 mm deep, more particularly between 200 and 270 mm deep. We have found that, by reducing the height of the blocks, the efficiency of the packing can be increased without changing its capacity. For example, we have found that reducing the height of the blocks by 50%, from 200 to 100 mm, the height of the packed bed, and thus the containing vessel, can be decreased by about 7% without changing its capacity.

Thus, in accordance with a third aspect of the present invention, there is provided a structured packing sheet which is adapted to be located in a column or tower so that one dimension of the sheet extends in the longitudinal direction of the column or tower or at an angle relative thereto, said sheet being corrugated so that the corrugations are inclined with respect of said one dimension, wherein the sheet has a length of less than 180 mm in said one dimension.

Preferably, the sheet has a length of 100 to less than 180 mm in said one dimension.

The packing sheet according to said third aspect of the present invention preferably also has features of the packing sheet according to said first aspect of the present invention.

According to a fourth aspect of the present invention, there is provided a column or tower containing a plurality of blocks, each block being formed of at least two adjacent packing sheets according to said third aspect of the present invention, wherein each block has a depth of less than 180 mm in the longitudinal direction of extent of the column or tower.

The invention in its third and fourth aspects is particularly useful in the field of high capacity cryogenic air separation where a relatively high pressure column is located below a relatively low pressure column. Thus, the present invention further resides in the use of a tower or column according to said fourth aspect of the present invention in a cryogenic air separation plant.

In such air separation, air is fed to the bottom of the relatively high pressure column after having been compressed and cooled using the products of the separation process. Nitrogen is liquefied in the relatively high pressure column and is fed as reflux to the top of the relatively low pressure column where oxygen is separated out. With high capacity cryogenic air separation, the compressing costs represents a significant part of the cost of gas separation. The heights of the columns are particularly important as they have to be fully lagged. The present invention in its third and fourth aspects enables the heights of the columns to be reduced as compared with a cryogenic air separator having a standard height of block of about 200 to 270 mm.

The present invention also resides in a method of transferring heat and/or mass using a packing sheet or apparatus according to any of said first to fourth aspects of the present invention, and in a plate-fin heat exchanger in which at least one fin takes the shape of a structured packing sheet according to said first aspect of the present invention.

The following applies to the present invention in all of its aspects:-

The wavelengths of the corrugations perpendicular to their direction of extent, the ratio of maximum-to-minimum cross-sectional areas of the

channels, the distance between the minimum and maximum cross-sectional areas in the longitudinal direction of the channels, the angles of the walls of the channels, and the height thereof may be selected to suit the intended application.

The channels may be linear or non-linear (eg angled or curved) in their direction of extent, and may be angular or smoothly curved in their cross-sectional shape.

The ratio of minimum to maximum cross-sectional areas of each of the first and second channels is preferably between 0.5 and 0.25.

The channels may be inclined at an angle of up to 70° with respect to the direction of bulk vapour flow relative to the sheet in use. Such angle may be a fixed angle or an angle which changes longitudinally of the channels. The angle of the channels may be the same or different on different sheets in the same block of packing.

A non-corrugated sheet may be interposed between adjacent corrugated sheets.

At least one of the sheets may be perforated or unperforated and/or may have a plain or a textured surface.

The distance between the minimum and maximum cross-sectional area of each channel may be greater than or equal to the average hydraulic diameter of the channel.

The ratio of the minimum to maximum perimeter of the channels is preferably 0.8:1 to 1:1.

At least one of the sheets may be made from metal, plastics, ceramic or glass. At least one of the sheets may be made from, or include, a catalyst material. At least one of the sheets may be made at least in part from an adsorbent material, from a cloth woven from metal wires or from plastics filaments, from expanded metal or expanded plastics, or any combination of the above.

The blocks may be formed from mutually parallel packing sheets. The planes of the sheets may be orientated so as to extend longitudinally of the direction of extent of the column or tower or may be inclined relative thereto. Instead of being superimposed one upon the other to form a block, a pair of sheets may be placed together with opposing corrugations and coiled into a spiral to form the block.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:-
Fig 1 is a perspective view showing part of a structured packing sheet according to one embodiment of the present invention,
Fig 2 is a view similar to Fig 1 of a second embodiment of structured packing sheet,
Fig 3 is a cross-sectional view showing the mutual disposition of a plurality of superimposed sheets of the type illustrated in Fig 2, and
Figs 4 to 10 are perspective views showing parts of third to ninth embodiments of structured packing sheet according to the present invention.

Referring now to Fig 1 of the drawings, the structured packing sheet which is illustrated therein is formed of a pressed metal sheet indicated generally by reference numeral 10 having corrugations therein defining a set of first channels 12 which open onto an upper surface of the sheet 10 (as viewed in Fig 1) alternating with a set of second channels 14 opening onto a lower surface of the sheet 10 (as viewed in Fig 1). The sets of channels 12 and 14 extend continuously from one side edge of the sheet to an opposite side edge thereof.

Each first channel 12 has a cross sectional area which changes longitudinally of the channel 12. At each end of each first channel 12, the cross-sectional area is at a minimum and is of triangular shape. However, the cross-sectional area progressively increases to an intermediate location 16 which, in this embodiment, is disposed mid-way between the ends of each first channel 12. This produces a progressive widening and truncation of the channel 12 so that each channel 12 has opposed longitudinal side edges which are mutually separated, in a direction parallel to the opposite side edges of the sheet, by a distance which varies longitudinally of the direction of extent of the channel. It will therefore be appreciated that the cross sectional shape of each first channel 12 varies from triangular at each end to frusto-triangular at the intermediate location 16.

In complementary fashion, the shape of each second channel 14 varies progressively from frusto-triangular at each end to triangular at the intermediate location 16. As will be apparent from Fig 1 and from the above, the cross-sectional area of each second channel 14 changes from a maximum at each end to a minimum at the intermediate location 16. The above-described changes in the cross-sectional areas of the first and

second channels 12 and 14 are enabled by the provision of a pair of oppositely directed, elongated triangular base portions 17 in the base of each channel 12,14.

In Fig 2, the structured packing sheet is similar to that of Fig 1 and similar parts are accorded the same reference numerals. In this embodiment, however, each of the base portions 17 is replaced by a pair of mutually inclined base portions 17a and 17b which joint at a ridge 17c so that, in use, adjacent packing sheets touch only at points. The arrangement is such that the perimeter of each channel at any point along its length is constant. This reduces the risk of crease formation when a metal sheet is pressed to shape.

Fig 3 shows the stacking together of adjacent packing sheets of the type illustrated in Fig 2 in a packing block. In Fig 3, four superimposed packing sheets 10a to 10d are shown with the channels 12 and 14 of each packing sheet oppositely inclined to an adjacent packing sheet. The perimeter of each of the channels is formed of the sum of P_1 to P_4. The cross-sectional area of one of the first channels is typically shown cross-hatched in packing sheet 10b, whilst the cross-sectional area of one of the second channels 14 is typically shown cross-hatched in packing sheet 10a. As shown in Fig 3, the sheets 10a to 10d have their planes extending perpendicularly to the plane of the paper and the cross-section illustrated corresponds to a typical cross-section through part of a packing block in its stacked orientation in a column or tower.

In Fig 4, the arrangement of channels 12 and 14 is similar to that of Fig 2 except that, in the place of the ridges 17c, a rectangular base portion 17d

is provided which has a width which is smaller than the base of the triangular portions 17a and 17b.

In Fig 5, the channel cross-sections are of a similar shape to those of Fig 4 but the arrangement is such that, instead of the first channels 12 increasing in cross-section from each end inwardly to intermediate portion 16, the first channels 12 increase in cross-section from one end thereof to the intermediate region 16 whilst they decrease in cross-section from the opposite end to the intermediate region. In this manner, a hole 18 is defined which serves to provide communication between each first channel 12 and a respective second channel 14 on the opposite side of the packing sheet 10 whereby to allow passage of liquid and vapour from one side of the packing sheet 10 to the other.

In Fig 6, the basic cross-sectional shapes of the channels 12 and 14 are similar to those of Figs 2 and 3. However, in this embodiment, the amplitude of the corrugations at the intermediate region 16 is suddenly reversed so as to form holes 20 allowing the passage of liquid and vapour from one side of the packing sheet 10 to the other.

In all of the above-described embodiments, the peaks and troughs of the corrugations are mutually parallel. However, in the embodiment of Fig 7, the peaks and the troughs are mutually inclined and the sides of the channels 12 and 14 are curved except where they change from convergence to divergence.

In Fig 8, there are two types of first channel 12(1) and 12(2) on one side of the sheet and two types of second channel 14(1) and 14(2) on the other side of the packing sheet 10. For ease of understanding, the ends

of such channels have been double hatched in Fig 8. The channels 12(2) and 14(2) vanish alternately at the locations where channels 12(1) and 14(1) are of maximum cross-section.

In Fig 9, the corrugations, instead of extending generally linearly, are angled in their longitudinal direction of extent so that the region of each channel 12 or 14 on one side of the intermediate location 16 is inclined with respect to that region of the same channel which is on the opposite side of the intermediate location 16.

In Fig 10, each first channel 12 has an intermediate region 12a of constant cross-sectional area and shape, whilst both end regions 12b and 12c of each first channel 12 have changing cross-sectional areas and shapes. In the particular embodiment illustrated in Fig 10, each of the end regions 12a and 12b of each first channel 12 has a cross-sectional area which increases progressively towards the intermediate region 12a. The second channels 14 have a cross-sectional shape which is complementary to that of the first channels 12.

In the above described embodiments, the channel shapes are shown with sharp folds in the flat metal sheet used to produce the channels. However, in practice, it may be more convenient to manufacture the channels by bending the metal sheet to produce curves rather than sharp folds. The sheets may be fabricated by pressing metal sheet, and in which case the perimeter of the channels in all cross-sections thereof along the lengths of the channels is preferably the same so as to minimise creasing of the sheet. However, this is not an essential requirement, particularly if the sheets are formed of plastics, e.g. by vacuum forming.

In the illustrated embodiments, the channels converge or diverge only once or twice along their length. However, it is within the scope of the present invention to provide any number of converging and diverging sections in one or any number of the channels.

Although not shown in the drawings, the sheets may be perforated and/or may have any surface texture applied thereto by stamping or rolling in order to increase the effected surface area of the sheets.

In a typical method of manufacturing the sheets, flat sheet metal is supplied in a coil about 200 mm wide and is first perforated by punching holes in it. Then, any surface texture applied by stamping or rolling. Corrugations of the required form to define the first and second channels are then formed by pressing the sheet between a shaped tool and die. One or more corrugations may be formed at a time. Before superposing corrugated sheets to form blocks, the continuous corrugated sheet is cut into appropriate lengths, preferably by sawing or grinding. It may be cut with a guillotine provided that care is taken not to distort the channels near the edge of the sheet.

Alternatively, the sheet may be manufactured by another technique, for example vacuum-forming or casting.

CLAIMS

1. A structured packing sheet for promoting contact between two streams in a tower or column, said structured packing sheet having corrugations therein defining a set of first channels opening onto one surface of the sheet alternating with a set of second channels opening onto the opposite surface of the sheet, the channels extending between opposite side edges of the sheet, wherein the cross-sectional area of each channel, as measured in a plane perpendicular to the medial line of the channel, changes longitudinally of the channel.

2. A structured packing sheet as claimed in claim 1, wherein each channel has opposed longitudinal side edges which are mutually separated, in a direction parallel to the side edges of the sheet, by a distance which varies longitudinally of the direction of extent of the channel.

3. A structured packing sheet as claimed in claim 1 or 2, wherein the channels are linear.

4. A structured packing sheet as claimed in claim 1, 2 or 3, wherein the cross-sectional area of each channel changes longitudinally from relatively large to relatively small at least once over the length thereof.

5. A structured packing sheet as claimed in claim 4, wherein the cross-sectional area of each of the first channels changes longitudinally from a maximum at each end thereof to a minimum at a location intermediate said ends, whilst the cross-sectional area of each of the

second channels changes from a minimum at each of its ends to a maximum at a corresponding location intermediate the ends.

6. A structured packing sheet as claimed in claim 5, wherein the change in the cross-sectional area of each channel is substantially progressive.

7. A structured packing sheet as claimed in claim 1, 2 or 3, wherein at least one opening in each channel providing intercommunication between opposite sides of the sheet is defined by an abrupt change in the cross-sectional areas of the channel at at least one intermediate location intermediate the ends of the channel.

8. A structured packing sheet as claimed in claim 7, wherein the cross-sectional area of each of the first channels changes from a maximum at one of its ends to a minimum at said intermediate location, but changes from a minimum at the opposite end to a maximum at said intermediate location, the second channels being of complementary shape to the first channels so that said opening is defined in each channel.

9. A structured packing sheet as claimed in any one of claims 1 to 8, wherein the ratio of minimum to maximum cross-sectional areas of each of the first and second channels is between 0.5 and 0.25.

10. A structured packing sheet as claimed in any one of claims 1 to 9, wherein the channels are inclined at an angle of up to 70° with respect to the direction of bulk vapour flow relative to the sheet in use.

11. A structured packing sheet as claimed in any one of claims 1 to 10, wherein a non-corrugated sheet is interposed between adjacent corrugated sheets.

12. A plate-fin heat exchanger in which at least one fin takes the shape of a structured packing sheet as claimed in any one of claims 1 to 11.

13. A column or tower containing a plurality of packing sheets as claimed in any preceding claim, wherein the packing sheets are disposed in the column or tower so that their planes extend in the direction of extent of said column or tower or are inclined relative thereto.

14. A column or tower as claimed in claim 13, wherein the packing sheets are arranged in blocks which are stacked in the column or tower.

15. A column or tower as claimed in claim 14, wherein the blocks have a height of less than 180mm.

16. A column or tower as claimed in claim 14, wherein blocks have a height of from 100mm to less than 180mm.

17. A structured packing sheet which is adapted to be located in a column or tower so that one dimension of the sheet extends in the longitudinal direction of the column or tower or at an angle relative thereto, said sheet being corrugated so that the corrugations are inclined with respect of said one dimension, wherein the sheet has a length of less than 180 mm in said one dimension.

18. A structured packing sheet as claimed in claim 17, wherein the sheet has a length of 100 mm to less than 180 mm in said one dimension.

19. A structured packing sheet as claimed in claim 17 or 18, having the features of the packing sheet as claimed in any one of claims 1 to 11.

20. A column or tower containing a plurality of blocks, each block being formed of at least two adjacent packing sheets as claimed in claim 17, 18 or 19, wherein each block has a depth of less than 180 mm in the longitudinal direction of extent of the column or tower.

21. A cryogenic air separation plant including a column or tower as claimed in claim 13, 14, 15, 16 or 20.

22. A method of transferring heat and/or mass using a packing sheet as claimed in any one of claims 1 to 12, 17, 18 and 19 or a column or tower as claimed in claim 13, 14, 15, 16 or 20.

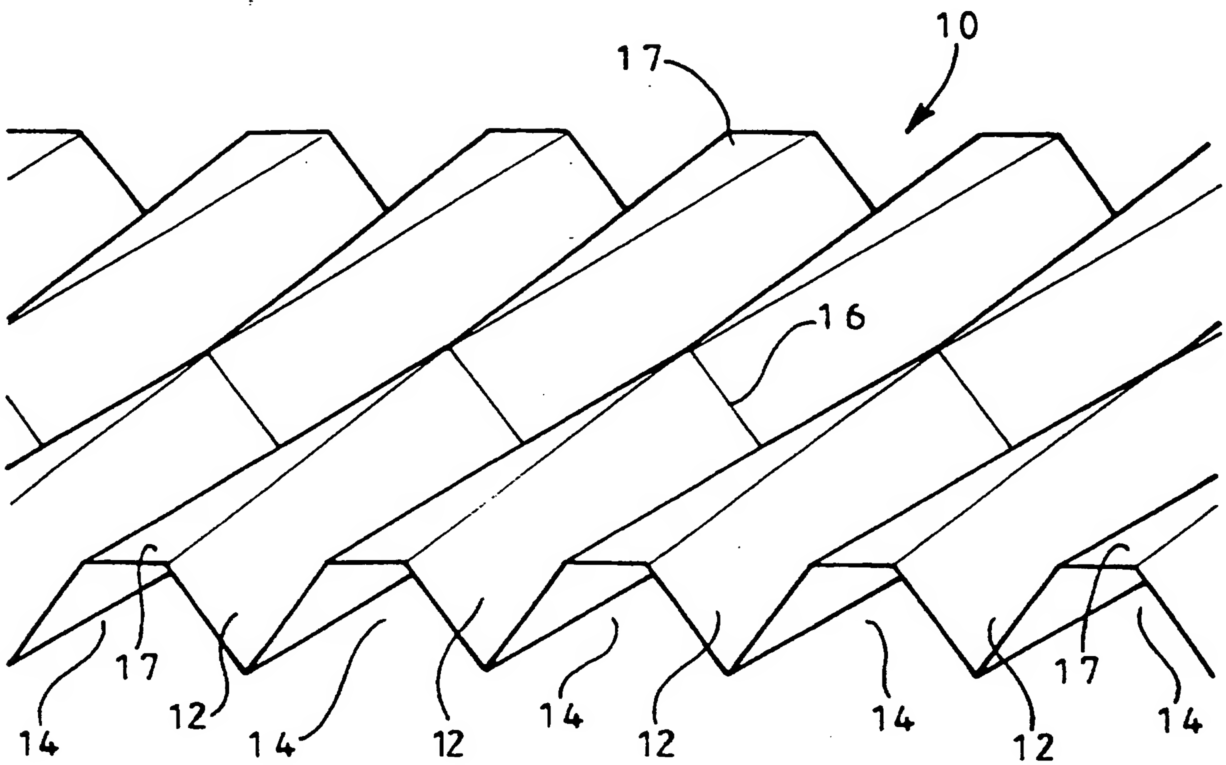
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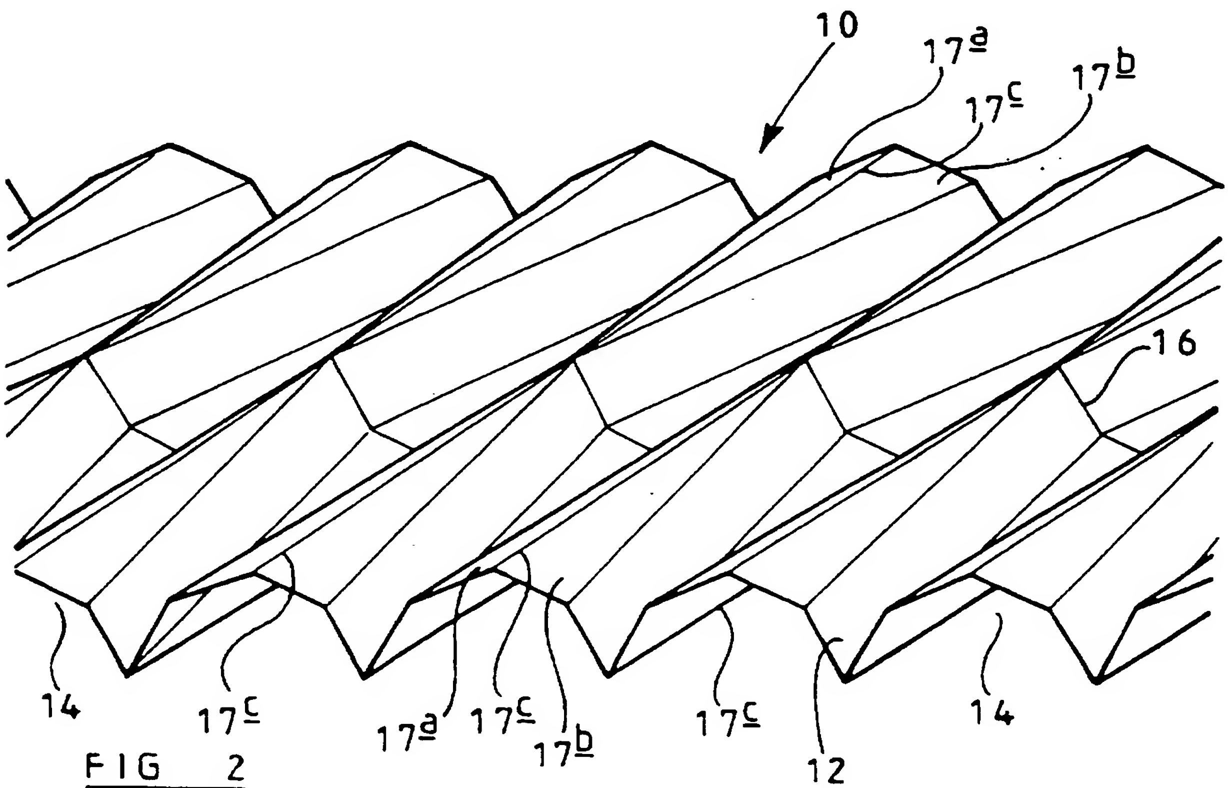
FIG 1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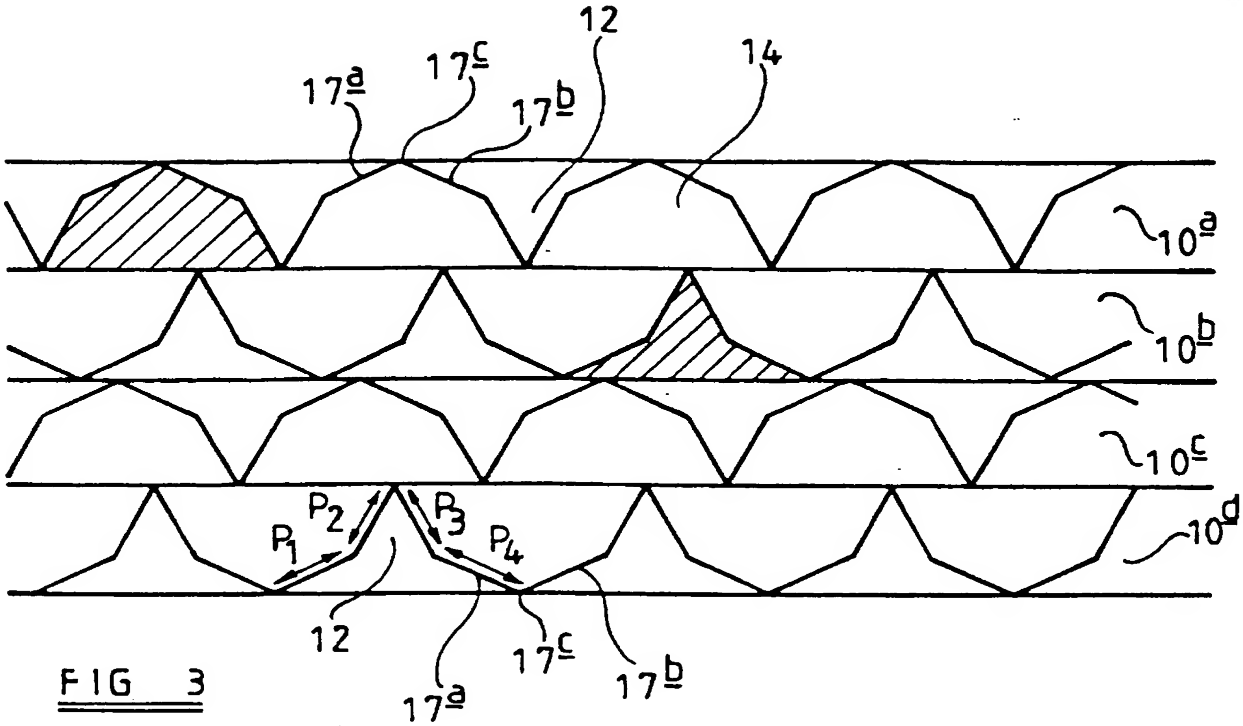
12
14

FIG 2


12
14
17a
17c
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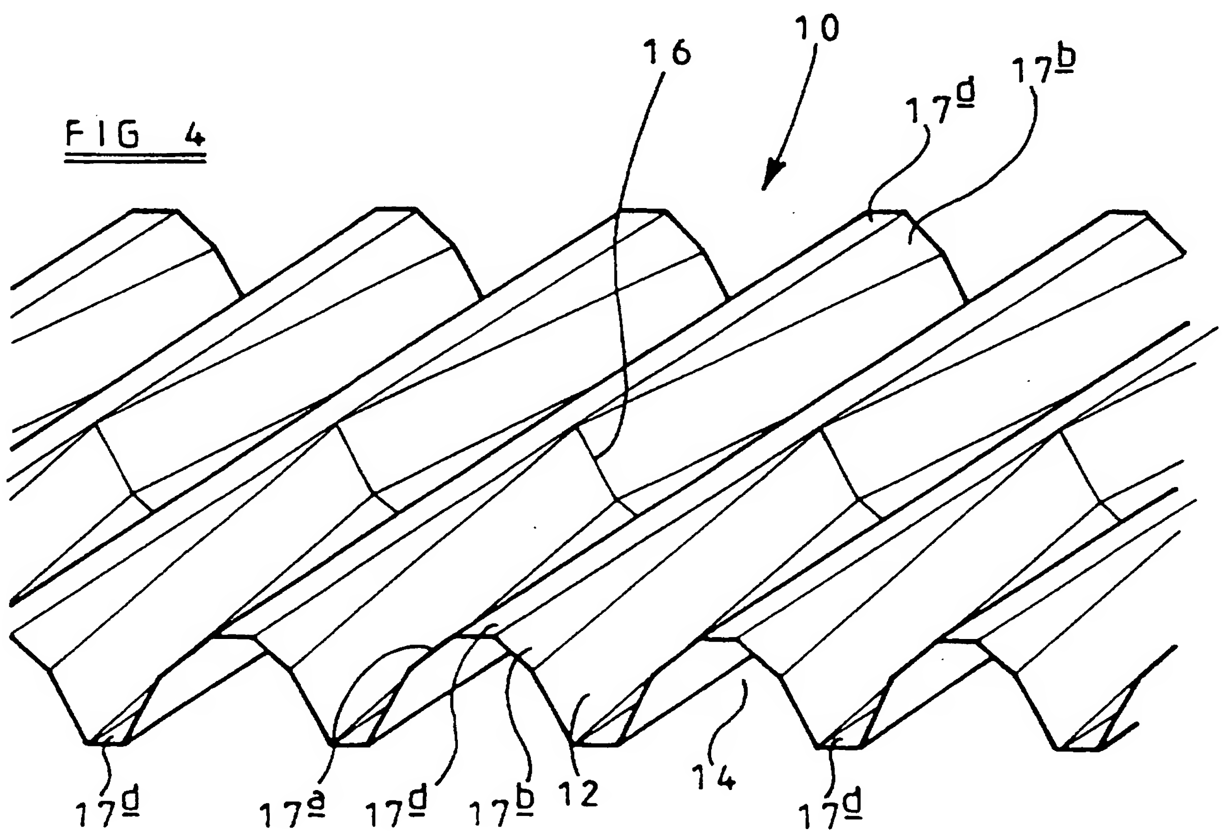
10b
10c
10d
P1
P2
P3
P4
12
17a
17c
17b

FIG 3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17b
17d
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12
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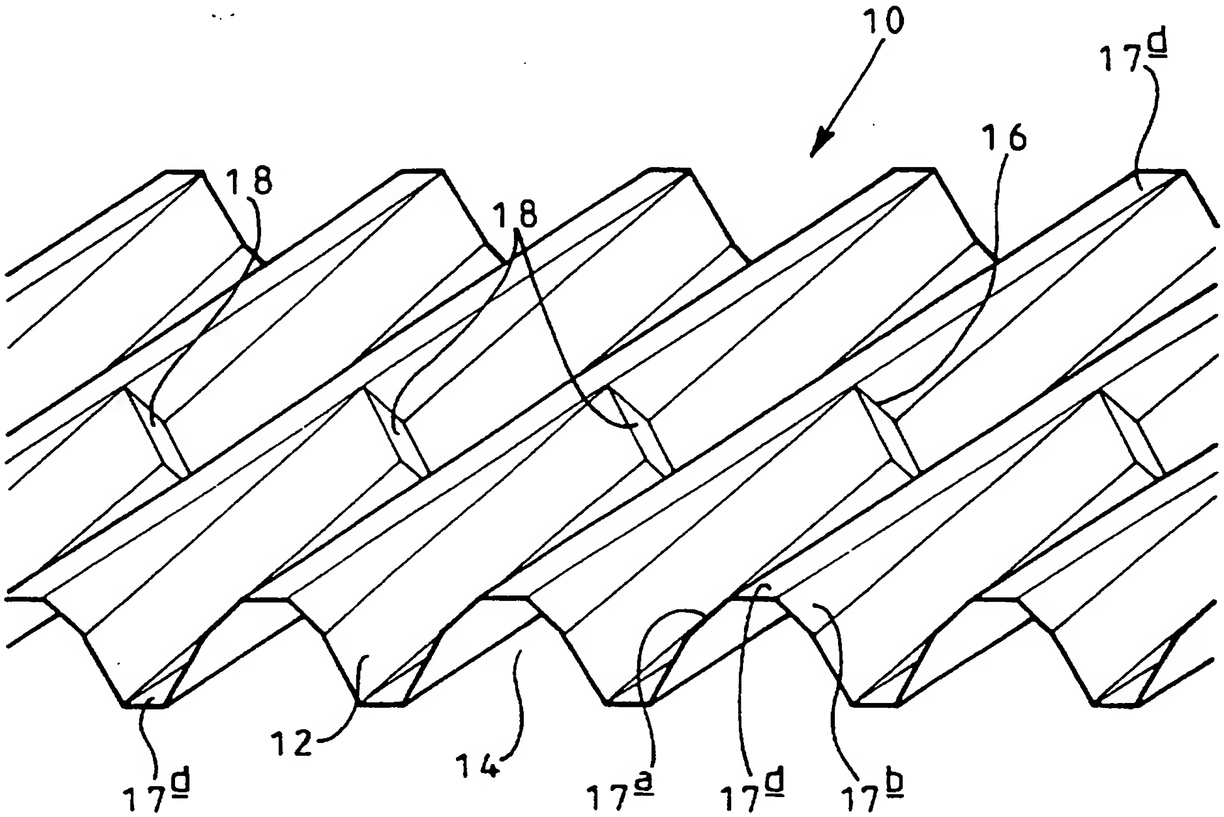
17d

FIG 4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17d
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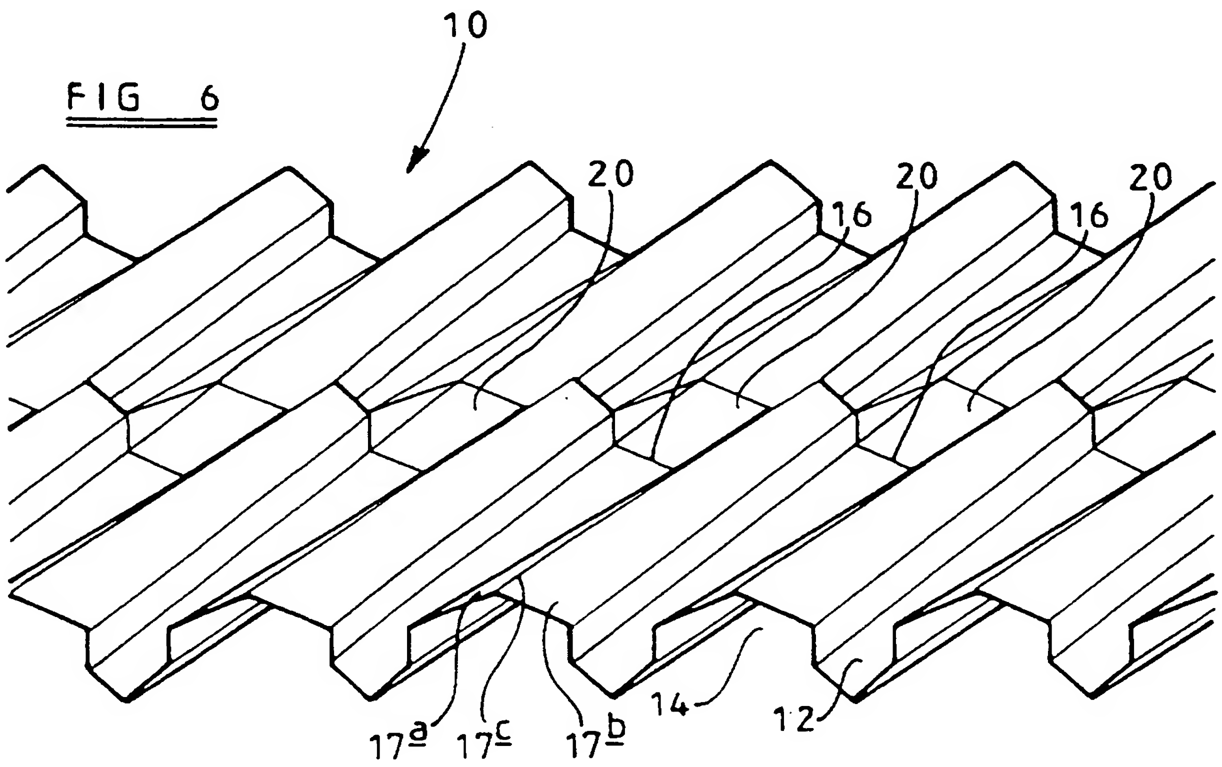
FIG 5

FIG 6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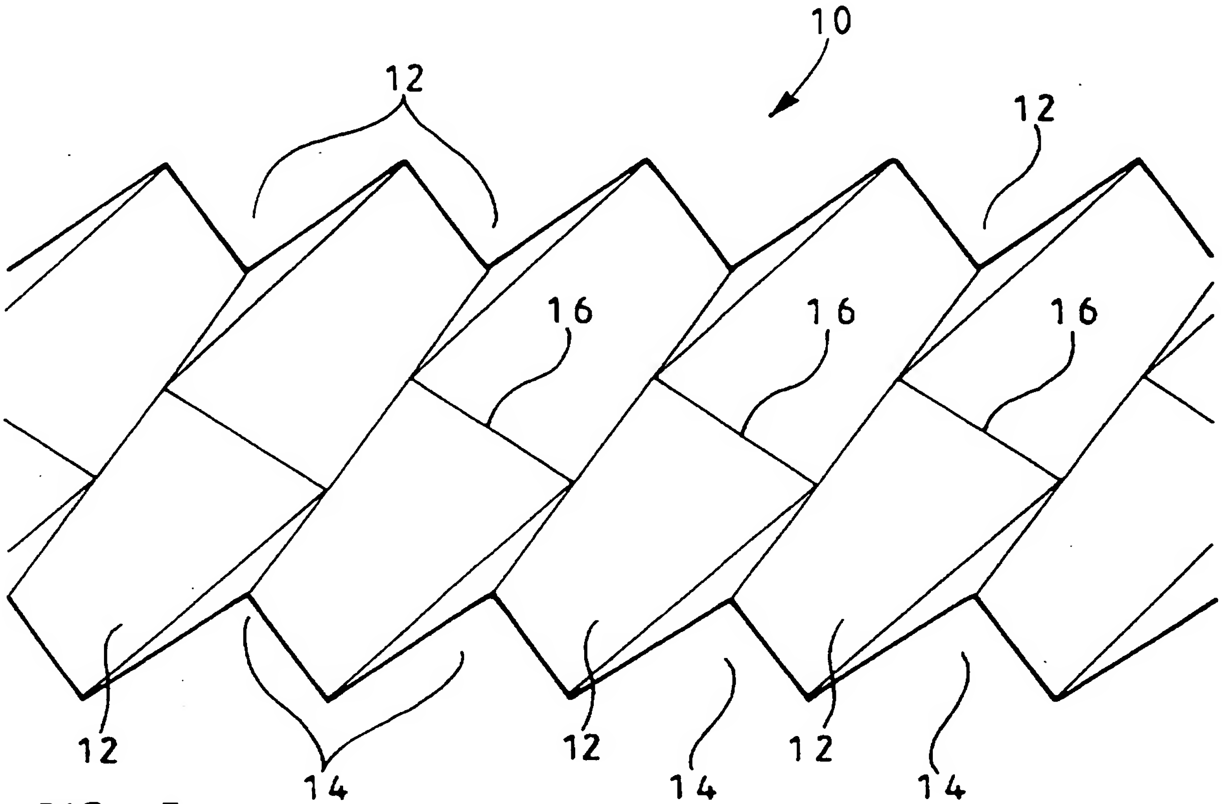


FIG 7

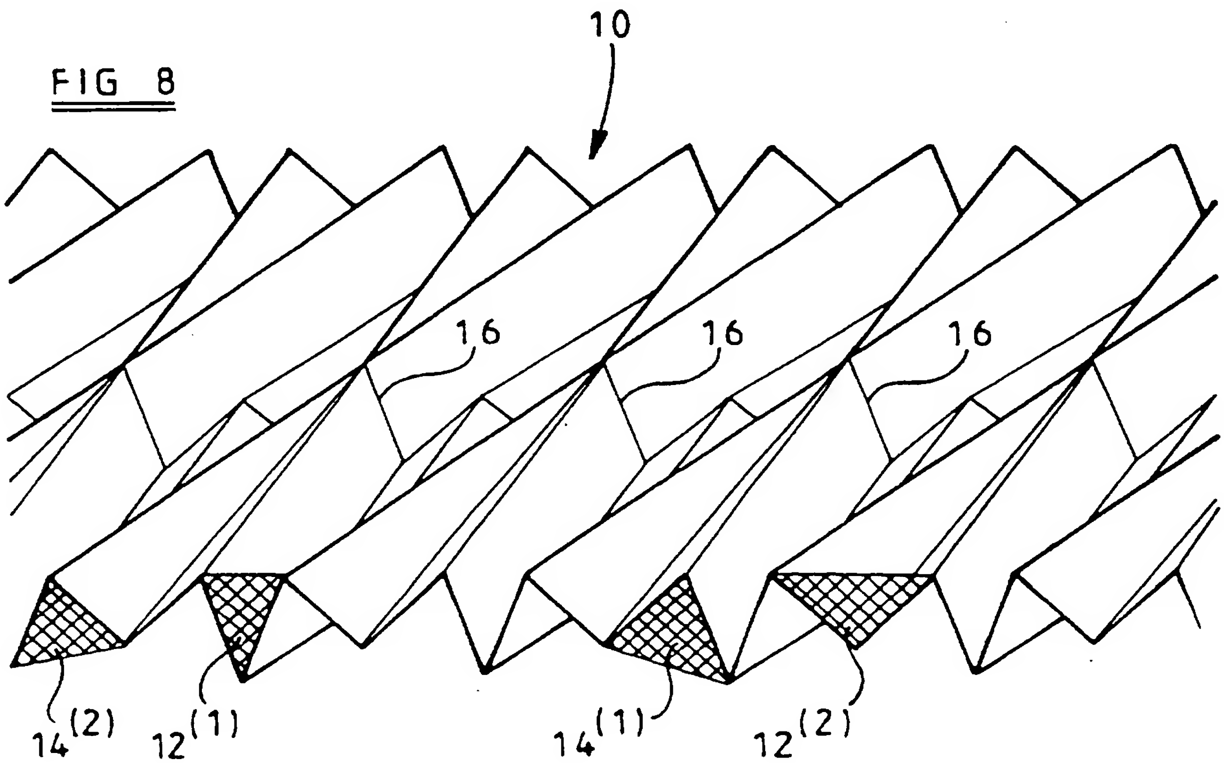


FIG 8

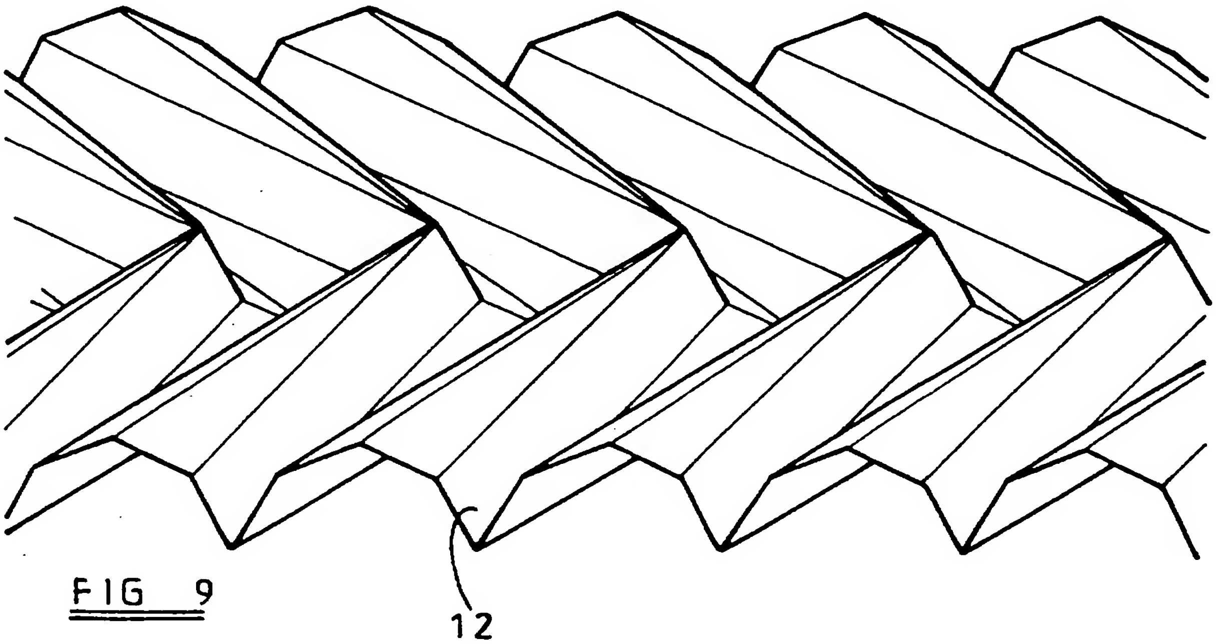
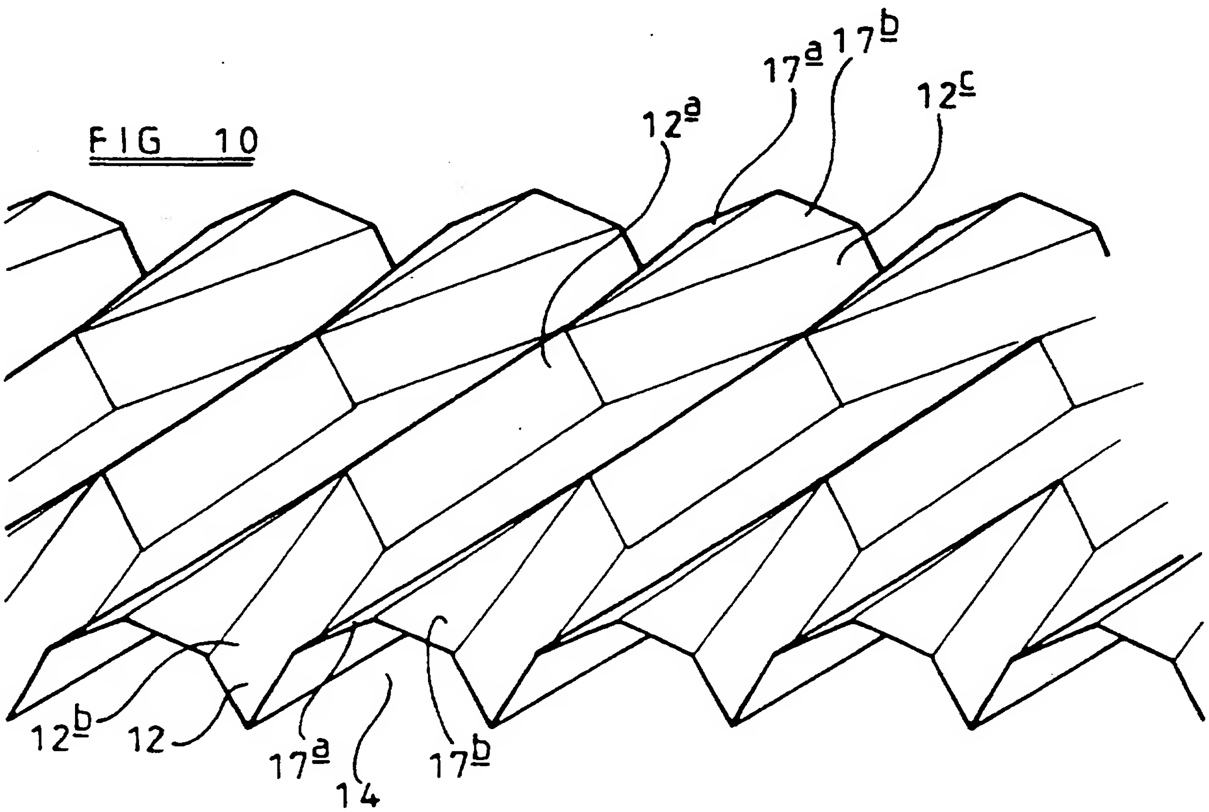


FIG 9

FIG 10



INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 97/01398

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B01J19/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 87 05827 A (FABRY GYOERGY;MANCZINGER JOZSEF) 8 October 1987 see claims 1,2,8; figures 1-3,6	1-4,13, 14
A	see page 7, line 31 - line 37; claims 4,5 ---	9
X	US 4 905 313 A (STACKHOUSE DAVID W) 27 February 1990 see column 3, line 33 - line 35; claim 1; figures 2,3 see column 4, line 3 - line 11	1,4-6, 10,22
A	---	12-14
X	CH 493 814 A (HEINZ FAIGLE) 15 July 1970 see figure 5 ---	1,3,11
A	CH 685 430 A (MAX J LIEBER) 14 July 1995 see figure 1A -----	1,7,8

[ ] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte. ...onal Application No
PCT/GB 97/01398

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 8705827 A	08-10-87	EP 0308430 A US 4915878 A	29-03-89 10-04-90
US 4905313 A	27-02-90	NONE	
CH 493814 A	15-07-70	DE 1601131 A US 3485485 A	16-07-70 23-12-69
CH 685430 A	14-07-95	NONE	